2-D Momentum

Homework?

eg. a 1.0 kg cart is rolling at 3.0 m/s when it collides with a 2.0 kg cart at rest.

a) if they stick together, what is their velocity after the perfectly inelastic collision?

pt=ptf

1x3=3 = (2+1)v

v=1.0m/s

b) if the 1.0 kg cart bounces back at -1.0 m/s, what is the velocity of the 2.0 kg cart? Was the collision perfectly elastic?

pt=ptf

3kgm/s = -1kgm/s + 2.0kg v

v= 2.0m/s

perfectly elastic Ek is conserved

$1/2\ mv^2 = 1/2mv^2 + 1/2mv^2$

$1/2\ (1.0kg)(3.0m/s)^2 =? 1/2(1.0kg)(-1m/s)^2 +1/2(2kg)(2m/s)^2$

4.5J =? 0.5J + 4J = 4.5J

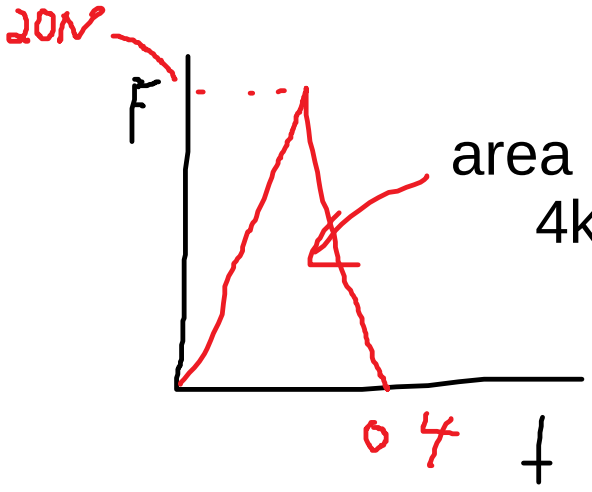
yes, it is perfectly elastic both momentum and kinetic energy are conserved

c) What would be the speeds after the collision if it was perfectly elastic?

see b (2 equations with 2 unknowns, solve)

d) for question b) if the carts are in contact for 0.40s, what is the average force on each cart?
$\Delta p = Ft$
$F = \Delta p/t$ = ((2kgx2m/s) - 0)/0.40s = 10N on the 2kg cart and -10N on the 1kg cart

If the force increases and decreases linearly, sketch the F-t graph.



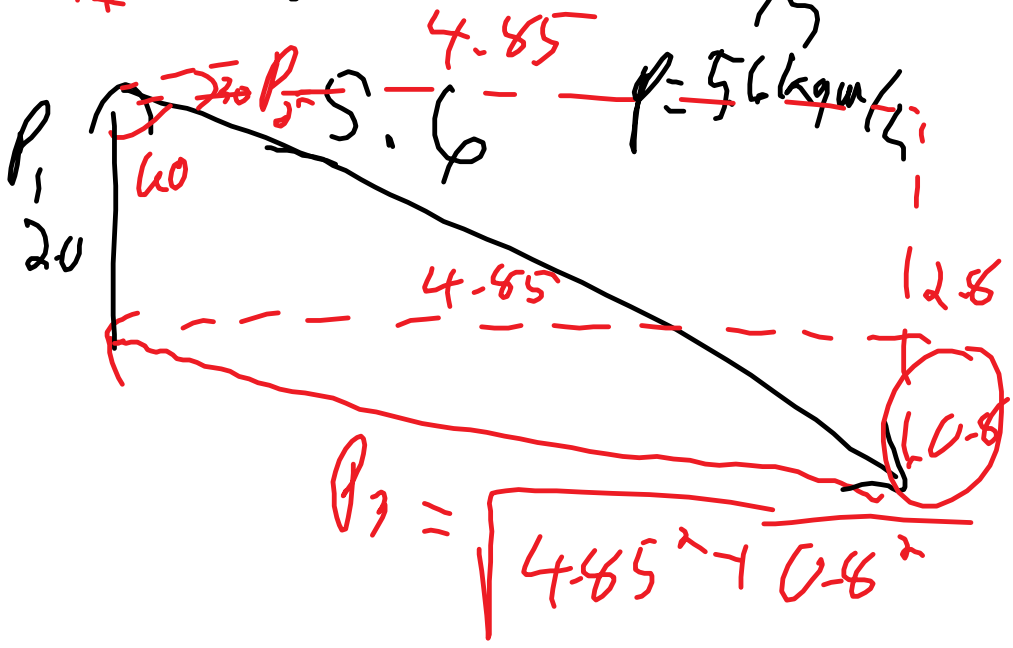
area = impulse = 1/2 basexheight
4kgm/s = 1/2 (0.40s)Fmax
Fmax = 20N

keeners if the force increases and decreases sinusoidally, sketch the F-t graph.
integrate the sine function

a) preview: A 1.0 kg bomb explodes into 3 pieces, 0.20 kg goes north at 10.0 m/s, 0.40 kg goes 30.0º South of East at 14.0m/s, what is the velocity

(magnitude and direction) of the 3rd piece?

$p_{ti} = 0 = p_{tf}$



$p_3 = \sqrt{4.85^2 + 0.8^2}$

$p_3 = 4.92 \text{ kg m/s}$

$V = \frac{p_3}{m_3} = \frac{4.92}{0.4}$

$\boxed{V = 12.3 \text{ m/s}}$

or cosine law

Sqrt(2^2+5.6^2-2x2x5.6xCos(60))=
4.915282290977803

4.915282290977803/0.4=
12.28820572744451 =12.3m/s

2D - Momentum same as 1-d but with vectors

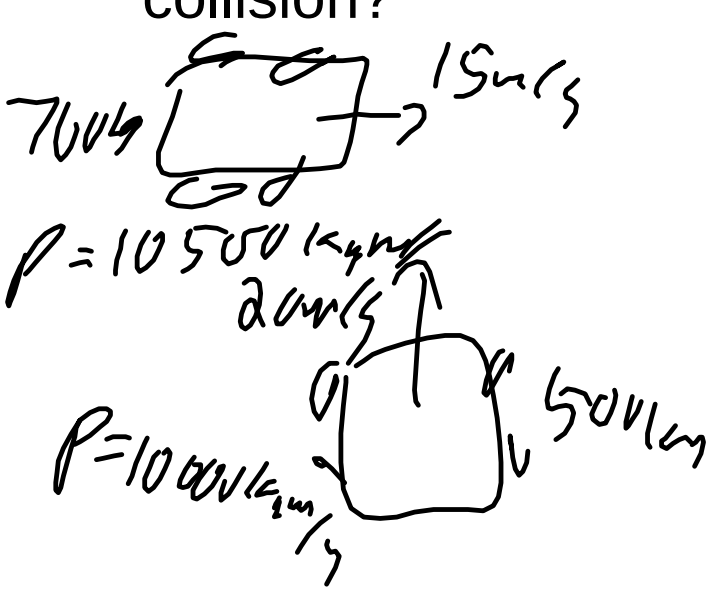
pti = ptf
pt is the vector sum of the momentum of all the objects in the system

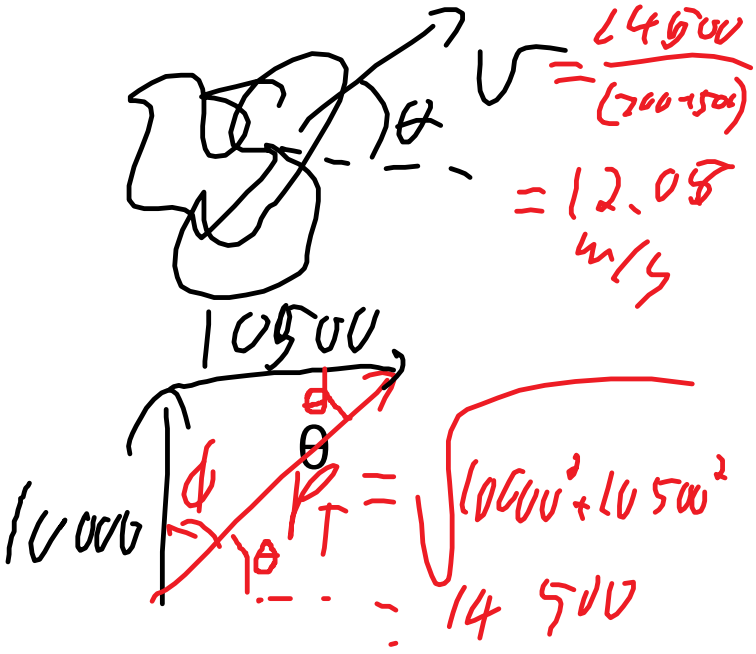
sometimes, you can use the shortcut
ptyi = ptyf
ptxi = ptxf
x component of the vectors and y component of the vectors obey conservation of momentum

eg.
A 500.0 kg car is moving North at 20.0m/s and collides with a 700.0kg car moving at 15.0 m/s.

a) if the 700kg car is moving East before the collision and they stick together, what is their speed and direction after the collision?

collision?

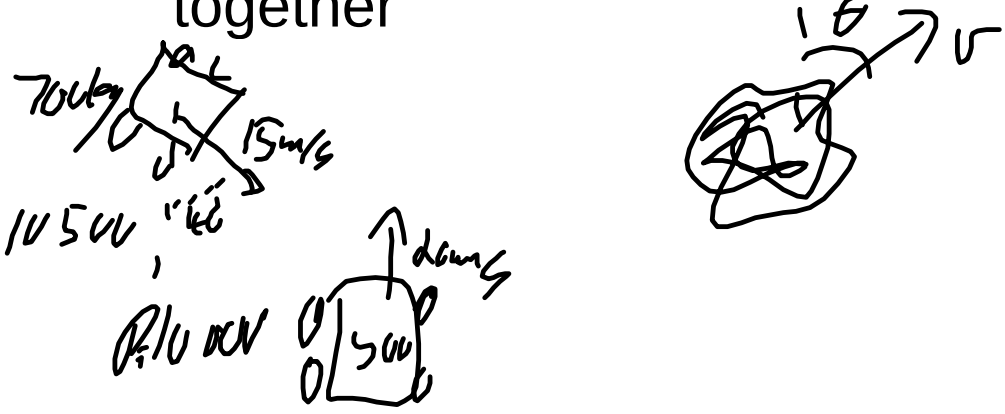


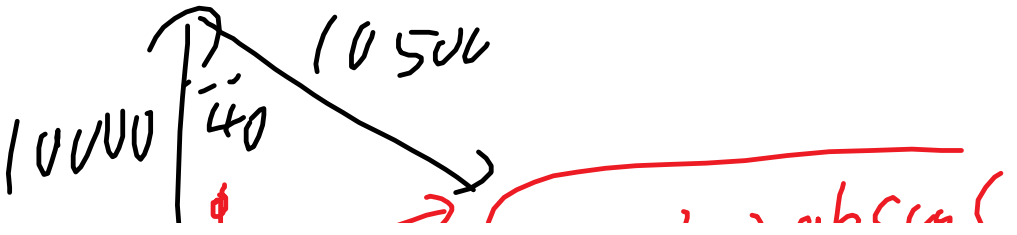


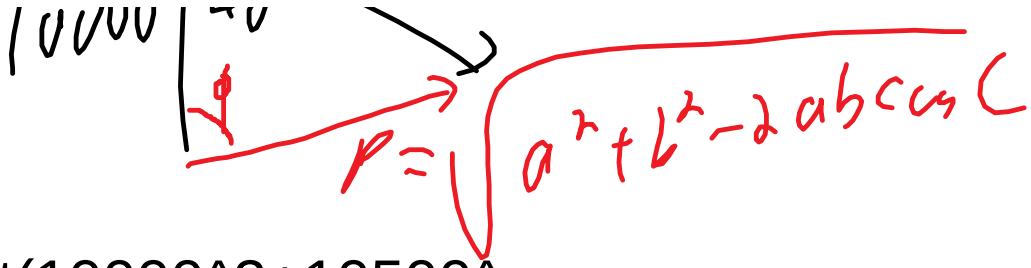
θ = Atan(10000/10500)= 43.60281897270362

12.08m/s 43.6º North of East

b) if the 700kg car is moving 40.0ºEast of South before the collision what is its velocity after the collision if i) stick together







Sqrt(10000^2+10500^
2-2x10000x10500xCos(40))=
7027.137891418854
v = 7027.137891418854/(500+700)=
5.855948242849 = 5.86m/s
ϕ = Asin(Sin(40)x10500/7027)=
73.83763160486135

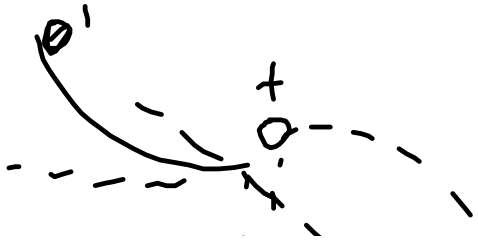
5.86m/s 73.8º East of North

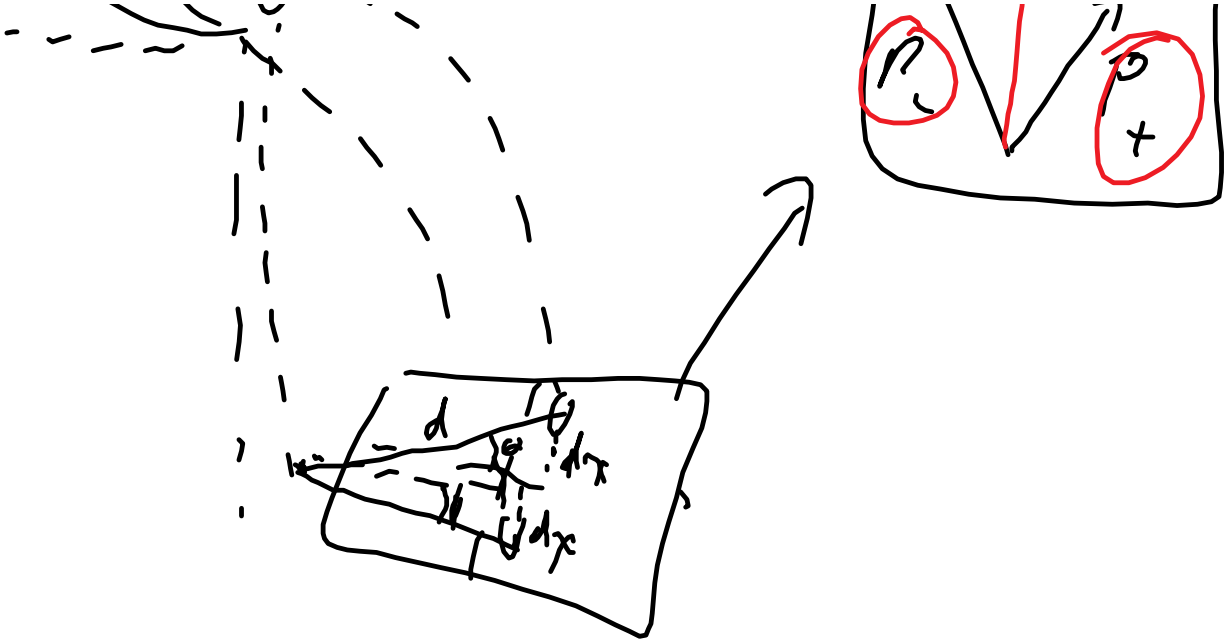
ii) it bounces off at 10.0m/s 20.0º West of South. Is this elastic?

a) prove that 2 equal mass objects bounce at 90º if they collide obliquely(not straight on) and perfectly elastic and one is at rest before the collision.

p169-170 Q23-33 odds

Lab next class:

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